Utility Energy Efficiency Results
Date: February 13, 2004
Utility: ARIZONA PUBLIC SERVICE CO.

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Est. 2003	<---Forecasted---> 2004	2005
UTILITY SYSTEM DATA														
Retail Energy Sales (MWh)	16,034,731	16,364,964	17,464,834	17,748,711	19,020,696	19,816,927	20,463,083	21,074,570	22,534,524	23,399,012	23,361,755	24,638,740	25,949,344	27,363,249
Annual Growth Rate: Energy (%)		2.1%	6.7%	1.6%	7.2%	4.2%	3.3%	3.0%	6.9%	3.8%	-0.2%	5.5%	5.3%	5.4%
Peak Demand (MW)	3,796	3,802	4,214	4,420	4,575	4,609	5,072	4,935	5,479	5,687	5,803	6,332	6,479	6,857
Annual Growth Rate: Peak Demand (%)		0.2%	10.8%	4.9%	3.5%	0.7%	10.0%	-2.7%	11.0%	3.8%	2.0%	9.1%	2.3%	5.8%
Retail Sales Revenue ($, millions)	$ 1,407	$ 1,437	$ 1,496	$ 1,502	$ 1,585	$ 1,620	$ 1,656	$ 1,716	$ 1,816	$ 1,867	$ 1,846	$ 1,931	$ 2,099	$ 2,289
ENERGY EFFICIENCY DATA														
Energy Efficiency Expenditures ($, 000)	$ 5,871	$ 6,150	$ 5,689	$ 6,957	$ 7,699	$ 5,517	$ 3,113	$ 2,210	$ 873	$ 4,991	$ 1,113	$ 1,000	$1,000	$1,100
Expenditures as % of Retail Revenues	0.42%	0.43%	0.38%	0.46%	0.49%	0.34%	0.19%	0.13%	0.05%	0.27%	0.06%	0.05%	0.05%	0.05%
Annual Energy Savings (MWh)	23,199	26,380	30,543	31,765	5,196	9,316	27,479	26,917	26,444	36,330	34,452	34,146	35,500	37,000
Annual Savings as % of Retail Sales	0.14%	0.16%	0.17%	0.18%	0.03%	0.05%	0.13%	0.13%	0.12%	0.16%	0.15%	0.14%	0.14%	0.14%
Cumulative Annual Effect (MWh)	23,199	49,579	80,122	111,887	117,083	126,399	153,878	180,795	207,239	243,569	278,021	312,167	347,667	384,667
Cumulative Annual Effect (% of Sales)	0.14%	0.30%	0.46%	0.63%	0.62%	0.64%	0.75%	0.86%	0.92%	1.04%	1.19%	1.27%	1.34%	1.41%
Lifetime Energy Savings (MWh)								457,432	443,738	550,647	568,288	451,476		
Annual Peak Demand Savings (MW)	37	28	30	32	22	19	27	21	24	29	28	28	29	30
Annual Savings as % of Peak Demand	0.96%	0.72%	0.70%	0.72%	0.48%	0.41%	0.53%	0.43%	0.44%	0.51%	0.48%	0.44%	0.45%	0.44%
Cumulative Annual Effect (MW)	37	64	94	125	147	166	193	214	238	267	295	323	352	382
Cumulative Annual Effect (% of Peak)	0.96%	1.68%	2.22%	2.83%	3.22%	3.61%	3.81%	4.34%	4.35%	4.70%	5.09%	5.10%	5.44%	5.57%
COST EFFECTIVENESS														
Spending per kW peak savings ($/kW)	$127	$208	$157	$134	$263	$253	$105	$87	$36	$172	$41	$32	$34	$36
Spending per kWh energy savings ($/kWh)	$0.20	$0.22	$0.15	$0.13	$1.12	$0.52	$0.10	$0.07	$0.03	$0.14	$0.03	$0.03	$0.03	$0.03

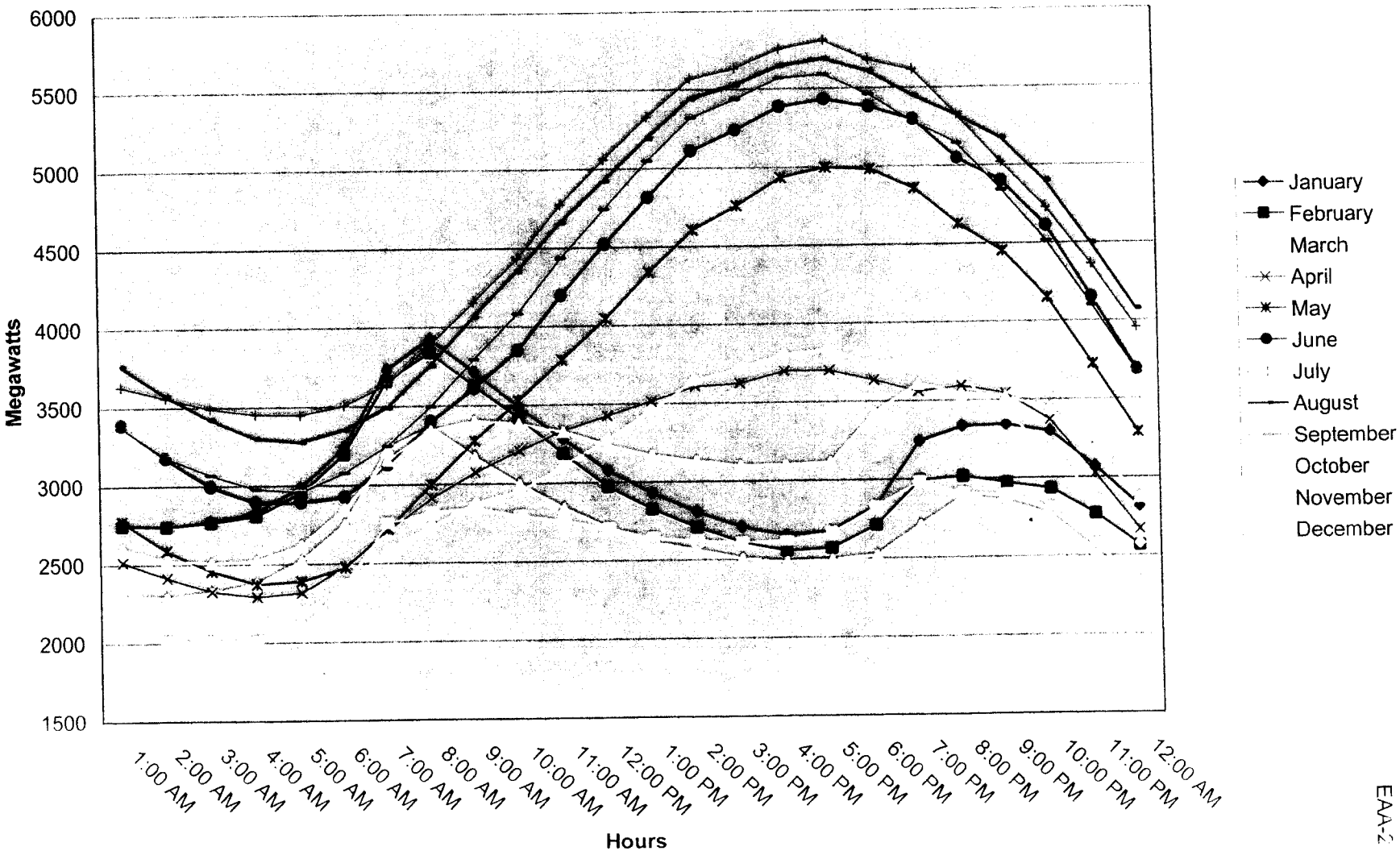
APS NOTES:
"Energy Efficiency Expenditures" includes direct implementation costs net lost revenue and utility financial incentives; does not include labor costs embedded in rates.
APS estimates that traditional DSM program administration required at least 25 FTE. Current MT program requires 3 FTE.
MT results can be difficult to measure. APS has used conservative estimates that do not claim savings for educational/training efforts that have produced significant market impacts.
MT has clearly been more cost effective in achieving DSM goals.

Annual Savings = Incremental annual (annualized) savings due to program in given year
Cumulative Annual Effect = Cumulative sum of annual savings over multiple years (sum should be adjusted by measure life for measures with short lives, where appropriate)
Lifetime Savings = Savings over the life of the measures due to program in a given year (annual savings X weighted average measure life)

Proposed Outline of Topics to be Covered in Staff's DSM Workshop Progress Report

1. **Purpose, scope and expectations of workshops**
2. **Presentations**
   - **Utility DSM programs: APS, TEP, UNS, SWG, AEPCO**
   - **SWEEP**
3. **Overview of historical and current DSM activities and results**
   - **Developed spreadsheets for each utility**
   - **Common format for all reporting**
4. **Discussion of criteria for evaluating DSM opportunities**
   - **Developed a consensus of criteria for identifying and screening opportunities**
5. **Identification of "Best Opportunities" in each market segment**
   - **Response to Commissioner Hatch-Miller**
   - **Individual lists from each utility, other parties**
6. **DSM Proposals**
   - **Utilities and other parties**
   - **Common format for presenting proposals**
7. **Potential Future Activities**
   - **Discussion of funding mechanisms**
   - **Utility lost revenue/financial incentives**
   - **Measurement and validation**
   - **Cost effectiveness tests**
8. **Recommendations for moving forward**

APS Peak Day Load Curve 2002



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APS energy SERVICES

Arizona Corporation Commission DSM Workshop Comments
February 13, 2004

The active market of energy efficiency projects is much larger than the reports show

- Data presented does not take into account non-participant adopters
- Results from DSM programs don't stand the test of time

APSES Experience

- Surveys of prior participants show DSM installations have been modified
- Cheaper inefficient material have replaced DSM material
- Control mechanisms are bypassed or disconnected
- Snapback effect supersedes conservation
- Maintenance and Operational behaviors have not been modified

Issues of DSM may not be utility oriented

- Customer behaviors are not changing. Consumers are indifferent
- Rebates are ineffective
- Barriers for institutional customer adoption are legislative, not regulatory. (e.g., excess utilities, shared savings)
- Most effective adoption comes through Federal Regulations and city mandates (e.g., 1992 Energy Policy on HVAC equipment, building codes, Phase out of T12 lamp manufacturing in the US, etc.)

Residential and Small C&I customers are best target markets for DSM

- DSM programs seem to stick in this segment

Large C&I customers are not motivated

- Utility costs represent less than 3% of overall operating costs for most
- Without a huge ROI (immediate payback), it's considered a lower priority

MEMORANDUM

TO: Barbara Keene and DSM Workshop Participants

FROM: David Berry

DATE: February 11, 2004

SUBJECT: DSM Workshop Programs/Measures

I would like to propose a **Shade Tree** DSM program.[1] The shade tree program should be part of a more comprehensive residential retrofit program and shade trees should be included with a package of retrofit recommendations depending on characteristics of the houses. Shade trees provide the largest savings when the trees are planted on sun-struck sides of target houses. Target houses are:[2]

- Houses with dual cooling (evaporative cooling and air conditioning): best sites are houses with little or no window area on west facing walls but with a lot of window area on other walls.
- Houses having only air conditioning: best sites are houses with single pane windows and a lot of window area on the south facing wall.

Possible program features are shown in Table 1.

Table 1
Shade Tree Element of Residential Retrofit Program

Program Name	Description	DSM Measures	Other considerations	Participants (#/year)	Annual MW savings	Annual MWH savings	Annual cost
Shade trees	Component of residential retrofit package	Shade trees (!)	Largest savings occur when houses are targeted as described in text	10,000 houses assuming 3 trees per house	1.7 MW: greater savings at dual cooled houses	3,840 MWH; greater savings at dual cooled houses	$300,000 excluding any rebate
Should be part of measurement and verification for residential retrofit package. May include spot field checks to ensure that trees are alive and properly located							

Program implementation should include marketing and consumer education about selecting, locating, planting, and caring for trees. Implementation includes some spot verification that the trees are planted and located so as to cast shade on the house. These

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[1] The *Arizona Republic* ran an editorial on the values of shade trees on September 17, 2003. The editorial recommended that 30 percent of the Phoenix land area be covered with trees.

[2] Kim Clark and David Berry, "Targeting Residential Conservation Measures," *Home Energy*, September/October 1994: 14-15. Kim Clark and David Berry, "House Characteristics and the Effectiveness of Energy Conservation Measures," *Journal of the American Planning Association*, vol. 61, Summer 1995: 386-395.

costs do not include any buydown or rebate of costs which are transfer payments. Thus a buydown or rebate could be added that would not decrease societal benefits, but which would increase utility costs.

Supporting analyses are presented below.

Shade Tree Benefits

Trees provide the following benefits:[3]

- Reduced air conditioning load due to shade, evapo-transpirational cooling, and wind reduction
- Avoidance and uptake of air pollutants (particulates, ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide)
- Reduced carbon dioxide in the atmosphere due to sequestration and avoided electricity generation
- Avoided runoff
- Wildlife and aesthetic benefits
- Increased property values capitalizing the energy savings and aesthetic benefits

Table 2 shows estimates of electricity savings from shade trees in dry climates.

Shade Tree Program Examples

Shade tree programs have been pursued by Tucson Electric Power, Mohave Electric Cooperative, Alliant Energy, and the Sacramento Municipal Utility District, for example. The SMUD program started in 1990 and has resulted in planting of 330,000 trees on 110,000 sites.[4] Some programs give trees away and others sell them at a discount. The SMUD program puts a heavy emphasis on consumer education (regarding how to plant and care for trees) and has a community forester site the trees at the customer's house or building to maximize energy savings. TEP works in partnership with Trees for Tucson and has planted more than 26,000 trees.[5] Note that utility programs typically provide smaller trees so that it may take several years to achieve the energy saving potential of the trees.

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[3] E. Gregory McPherson, "Evaluating the Cost Effectiveness of Shade Trees for Demand-Side Management," *The Electricity Journal*, vol. 6, no. 9, November 1993: 57-65.

[4] ACEEE, Shade Tree Program, Sacramento Municipal Utility District.

[5] TEP: www.tucsonelectric.com/Community/Environment/Trees.html, accessed February 6, 2004.

Table 2
Electricity Savings Attributable to Shade Trees

Area	Reference	Savings
Phoenix	Kim Clark and David Berry, "Targeting Residential Conservation Measures," *Home Energy*, September/October 1994: 14-15. Kim Clark and David Berry, "House Characteristics and the Effectiveness of Energy Conservation Measures," *Journal of the American Planning Association*, vol. 61, Summer 1995: 386-395.	• 3 large trees shading air conditioned houses ✓ Average house: .05 kW and 36 kWh per year ✓ Target house (single pane windows, more window area on south facing wall): 0.17 kW and 384 kWh per year • 3 large trees shading dual cooled houses (evaporative cooling and air conditioning) ✓ Average house: .02 kW and 810 kWh per year ✓ Target house (smaller fraction of west facing wall in windows, greater fraction of all walls in window area): 0.35 kW and 956 kWh per year
Sacramento	James Simpson, "Urban Forest Impacts on Regional Cooling and Heating Energy Use: Sacramento County Case Study," *Journal of Arboriculture*, vol. 24, July 1998: 201-214.	• Reduction in kWh use for air conditioning due to existing trees: ✓ For residential, commercial, and industrial buildings combined: 10.9% ✓ For 1-4 family residences only: 21.3% • Reduction in peak air conditioning kW due to existing trees: ✓ For residential, commercial, and industrial buildings combined: 6.1% ✓ For 1-4 family residences only: 12.9%
Tucson	E. Gregory McPherson, "Evaluating the Cost Effectiveness of Shade Trees for Demand-Side Management," *The Electricity Journal*, vol. 6, no. 9, November 1993: 57-65.	Savings due to shade* from one deciduous tree opposite west wall of energy efficient 2 story home: • 400 kWh saved per year for 24 foot tree (smaller savings for smaller trees) • 0.5 kW savings for 24 foot tree (smaller savings for smaller trees) * savings do not include savings attributable to evapo-transpirational cooling or reduced wind speed

Program Assumptions

The costs and benefits of a shade tree program depend on the species to be planted, tree locations, tree size at planting (small or large enough to cast shade immediately), the assumed baseline (what would the property owner have done in the absence of the tree program), and other factors. Program assumptions, costs, and benefits are presented in Table 3 on a per-tree basis.

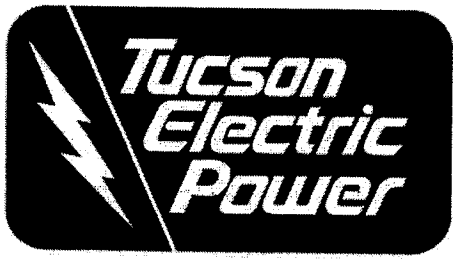
Table 3
Program Assumptions, Costs and Benefits per Shade Tree in Phoenix

Factor	Assumption or Result
1. Baseline	No tree to be planted. If property owner was going a plant a tree in another location, the incremental costs might be less. If property owner gardens as a hobby, costs might be less.
2. Cost of tree, increased by 25% to replace trees that die in first year	$40 x 1.25 = $50 ($40 cost is for a 15 gallon sweet acacia; quote from Treeland in Mesa, January 2004)
3. Years until shade is provided	5 years (would be less if a larger, more expensive tree were purchased)
4. Planting cost	$10 (see baseline assumptions)
5. Annual water usage	1,200 gallons. Some trees might require less water after they are mature
6. Annual O&M cost	$1.00
7. Life of tree	40 years
8. kW savings	0.17/3 = 0.057 kW for one tree at a target air conditioned house per Clark and Berry study, Table 2 above*
9. kWh savings	= 384 kWh per year/3 = 128 kWh per year for one tree at a target air conditioned house per Clark and Berry study, Table 2 above*
10. Utility avoided capacity cost	$63 per kW per year based on fixed costs of a new combustion turbine
11. Utility avoided energy cost	$0.03 per kWh for marginal units
12. Incremental cost of water	$1.32 per 1000 gallons (Scottsdale rate)
13. Rate of inflation	2.5% per year
14. Discount rate for present value	5.5%
15. Present value of net benefits for one tree at a target house	$25

* larger savings would be obtained from targeted dual cooled houses.

ACC DSM Workshop
February 13, 2004

Proposed Program Development
For
Tucson Electric Power



A UniSource Energy Company

DSM Workshop Proposal Tucson Electric Power - Existing Res/Low Income Segment

Program Name	Description	DSM Measures	Other Considerations (Feasibility, market share, MT effect)	Participants (est #/yr)	Est Annual Savings (MW)	Est Annual Savings (MWH)	Est Annual Spending ($,000)
Guarantee Program	Residential New Construction	TEP currently reports MW and MMbtu savings.	Need to determine how to calculate MWh savings	1,000	0.003		$1,044,000
On-Line Energy Advisor	On-line energy audit with bill history download	No defined measures	MT	5,000	0.0	0	$70,000
Low-Income Weatherization Program	Weatherization of homes for low income customers	No defined measures	Agency administrators do not have the necessary resources to Weatherize additional homes in TEP's service territory	145	0.0	0	$198,000
Academic Education	Education programs for K-12 schools.	No defined measures	MT	NA	0.0	0	$48,000
Trees Program	Desert-adapted trees are given to residential neighborhoods, schools, low-income families and public areas.	No defined measures	MT	4,800	0.0	0	$135,000
Measurement and Verification	It will be necessary to create a database to meausure and verify energy savings for programs. Routine reports will be generated to determine energy savings, and TEP will report results in its semi-annual and year-end DSM reports.						
			TOTAL	**10,945**	**0.0**	**0**	**$1,495,000**

DSM Workshop Proposal Tucson Electric Power - New Residential Segment							
Program Name	**Description**	**DSM Measures**	**Other Considerations** (Feasibility, market share, MT effect)	**Participants** (est #/yr)	**Est Annual Savings** (MW)	**Est Annual Savings** (MWH)	**Est Annual Spending** ($,000)
Appliance Rebate Program	Rebate for high efficiency Energy Star appliances	Societal test	Feasibility - high	1,000	0.0	0.70	$159,000
Air Duct Efficiency Program	Free inspection of a customer's home air conditioning and heating duct system. TEP pays 50% of repair costs not to exceed $300	Societal test	Feasibility - high	500	0.0	0.65	$206,000
Window Replacement Program	Rebate for installing energy efficient windows (maximum rebate is $500)	$5.33 sq. ft. for site built homes and $3.48 squ ft for manufactured homes (up to $500)	Feasibility - high	426	0.0	0.40	$257,000
Measurement and Verification	It will be necessary to create a database to meausure and verify energy savings for programs. Routine reports will be generated to determine energy savings, and TEP will report results in its semi-annual and year-end DSM reports.						
			TOTAL	**1,926**	**0.0**	**2**	**$622,000**

DSM Workshop Proposal Tucson Electric Power - Commercial/Industrial/Institutional Segment

Program Name	Description	DSM Measures	Other Considerations (Feasibility, market share, MT effect)	Participants (est #/yr)	Est Annual Savings (MW)	Est Annual Savings (MWH)	Est Annual Spending ($,000)
C&I Energy Audits	One-on-one energy management services	Societal test	Feasibility - high	20	0.0	0	$104,000
C&I Training	Energy efficiency workshops for facility managers and facility management personnel	Societal test	Feasibility - high	300	0.0	0	$52,000
C&I Lighting Program	Rebates are offered for the installation of efficient lighting systems in new and existing facilities.	Societal test	Feasibility - high	100	0.03	54.00	$364,000
On-Line Energy Audit	On-line energy audit with bill download history	Societal test	MT	100	0.0	0	$75,000
C&I High Efficiency Cooling Systems Program	Rebates are offered for installation of unitary air conditioners, heat pumps, and chillers.	Societal test	Feasibility - high	300	0.30	540	$588,000
Measurement and Verification	It will be necessary to create a database to meausure and verify energy savings for programs. Routine reports will be generated to determine energy savings, and TEP will report results in its semi-annual and year-end DSM reports.						
			TOTAL	**820**	**0.3**	**594**	**$1,183,000**

DSM Workshop - Proposed DSM Portfolio Tucson Electric Power												
DSM SPENDING	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**TOTAL**
Total DSM Spending ($,000)	$3,300,000	$3,300,000	$3,300,000	$3,300,000	$3,300,000	$3,300,000	$3,300,000	$3,300,000	$3,300,000	$3,300,000	$3,300,000	**$36,300,000**
Existing Residential/Low Income	$1,495,000	$1,495,000	$1,495,000	$1,495,000	$1,495,000	$1,495,000	$1,495,000	$1,495,000	$1,495,000	$1,495,000	$1,495,000	$16,445,000
Residential New Construction	$622,000	$622,000	$622,000	$622,000	$622,000	$622,000	$622,000	$622,000	$622,000	$622,000	$622,000	$6,842,000
Commercial/Industrial/Institutional	$1,183,000	$1,183,000	$1,183,000	$1,183,000	$1,183,000	$1,183,000	$1,183,000	$1,183,000	$1,183,000	$1,183,000	$1,183,000	$13,013,000
Expenditure Impact on Rates (%)												
ENERGY/DEMAND SAVINGS												
Cumulative Annual Effect (mW)	0.3	0.7	1.0	1.3	1.7	2.0	2.3	2.7	3.0	3.3	3.7	**3.7**
Annual Peak Demand Savings (mW)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
Existing Residential/Low Income	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Residential New Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Commercial/Industrial/Institutional	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
Cumulative Annual Effect (mWh)	596	1,191	1,787	2,383	2,979	3,574	4,170	4,766	5,362	5,957	6,553	**6,553**
Annual Energy Savings (mWh)	596	596	596	596	596	596	596	596	596	596	596	
Existing Residential/Low Income	0	0	0	0	0	0	0	0	0	0	0	
Residential New Construction	2	2	2	2	2	2	2	2	2	2	2	
Commercial/Industrial/Institutional	594	594	594	594	594	594	594	594	594	594	594	
Lifetime Energy Savings (mWh)												
COST EFFECTIVENESS												
Spending per KW peak savings ($/kW)	9,921,828	9,921,828	9,921,828	9,921,828	9,921,828	9,921,828	9,921,828	9,921,828	9,921,828	9,921,828	9,921,828	***Average***
Spending per annual kWh savings ($/kWh)	5,539	5,539	5,539	5,539	5,539	5,539	5,539	5,539	5,539	5,539	5,539	9,921,828
Spending per lifetime kWh savings ($/kWh)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	5,539
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